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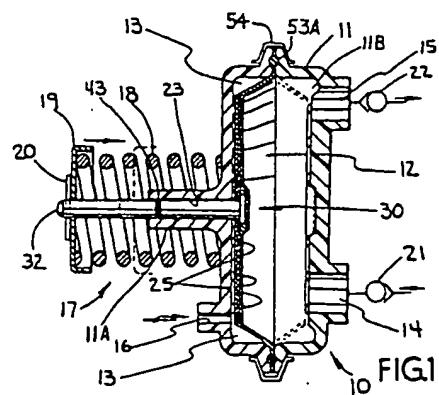
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(54) Fluid driven single-acting diaphragm pump and its diaphragm assembly.

(57) A pneumatically powerable single action fluid pump has a housing, an improved diaphragm assembly dividing the housing into fluidly discrete propellant and pumping chambers, a fluid inlet and outlet in the pumping chamber, a fluid port to the propellant chamber and a spring motor biasing the diaphragm assembly in a direction away from the pumping chamber side of the housing; the diaphragm assembly includes a perforate rigid diaphragm plate, an elongate motor stem connected to the plate, a contiguous elastomeric diaphragm having an imperforate front layer covering a front side of the plate and stem, a rear layer on a rear side of the plate, pins in the plate perforations and between and adjoining the diaphragm layers, and a bellows section to the outside of the plate. The spring motor biases the diaphragm to a position in close proximity to the fluid port of the propellant chamber in the absence of propellant therein against a plurality of spacer ribs. The spacer ribs permit an even and rapid distribution of propellant into the propellant chamber to drive the diaphragm assembly against the biasing action of the spring motor toward the pumping chamber.



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- 1 -

see front page

DIAPHRAGM ASSEMBLY FOR A DIAPHRAGM TYPE FLUID PUMP
AND PNEUMATICALLY POWERABLE SINGLE ACTION FLUID PUMP

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention pertains to a fast acting, expandible chamber fluid pump and a diaphragm assembly therefor.

5 DESCRIPTION OF THE PRIOR ART

Prior art diaphragms, or bellows are exemplified by a thin sheet of elastomeric resilient material which is intended to be fixedly grasped about its periphery, and which has a central aperture through which extends a motor shaft. Rigid reinforcing plates are secured to one or both sides of an elastomeric sheet and these plates are usually compressed to the sheet by fastener nuts on the motor shaft.

10 These prior diaphragms and reinforcing plates have presented the metal reinforcing plates in contact with the fluid being pumped. The result is trace quantities of metal in fluids being pumped.

15 The plate and fastener on the pumped fluid side of the diaphragm also present a crevice around their periphery. This crevice effects carry-over of fluid, trapping of fluid, contamination during periods of non-usage, and presents a cleaning and sanitation problem.

20 Mechanical fasteners used for retention of the plates to the motor stem usually require a chemical adhesive for reliability, but they still tend to come apart as well as presenting metal to pumped fluid and providing more crevices.

25 These problems are particularly acute when food products

- 2 -

1 are being pumped. Specific examples of these food products in-
clude soft drink syrups, milk, juice concentrates, chocolate and
the like. Minute traces of metal effect an off-taste character-
ized as being metallic, and effect spoilage of the food product.
5 Carry-over of caustic sanitizers effects off-tastes in the food
products.

10 Prior art expandible chamber fluid pumps also do not have
sufficiently fast response times to the introduction of propel-
lant fluid. These slow response times are obviously undesirable
for dispensing equipment used in fast food establishments.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide an improved diaphragm assembly for a diaphragm type fluid pump.

15 It is an object of the present invention to provide a fluid pump diaphragm assembly having a rigid plate and a motor stem and in which neither the plate nor the stem is exposed to fluid being pumped.

20 It is an object of the present invention to provide a fluid pump diaphragm assembly in which an imperforate diaphragm retains a motor stem in a rigid diaphragm plate.

It is an object of the present invention to provide an improved single action fluid pump having an improved diaphragm which does not present metal to the fluid being pumped.

25 It is an object of the present invention to provide a single action-fluid pump with an improved response time to propellant fluid.

- 2 -

- 3 -

1

SUMMARY OF THE INVENTION

In accordance with the principles of the present invention, a diaphragm assembly for a diaphragm type fluid pump has a rigid plate with a front side and a rear side, a motor stem connected to the plate and extending away from the rear side of the plate, and an elastomeric diaphragm molded to the plate and the stem. The diaphragm has an imperforate layer on the front side of the plate which covers the plate and stem from exposure to pumped fluid. At the beginning of a pumping stroke the rear side of the diaphragm is disposed closely adjacent a wall of the pump housing containing a liquid propellant inlet. Spacer ribs on that wall evenly and rapidly distribute incoming propellant against the rear side of the diaphragm to drive the same.

BRIEF DESCRIPTION OF THE DRAWINGS

15

Figure 1 is an elevational cross-sectional view of the preferred embodiment of a fluid pump in accordance with the principles of the present invention;

20

Figure 2 is an end elevational view of the preferred embodiment of a diaphragm assembly in accordance with the principles of the present invention and as shown in the pump of Figure 1;

25

Figure 3 is a side elevational view on partial section as taken through lines III-III of Figure 2;

Figure 4 is an end elevational view of the plate and stem of the diaphragm assembly of Figure 2; and

- 3 -

- 4 -

1 Figure 5 is a side elevational view in partial section,
as taken through lines V-V of Figure 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

5 The principles of the present invention are particularly useful when embodied in the fluid pump generally indicated by the number 10, and in the diaphragm assembly generally indicated by the numeral 30.

10 The pump 10 is a pneumatically powerable single action device having a two-piece housing 11, coupled together by a V-clamp 54, and a diaphragm assembly 30 which divides the interior of the housing 11 into a pumping chamber 12 and a propellant chamber 13. The pumping chamber 12 has a fluid inlet 14 with an incoming check valve 21 and a fluid outlet 15 with an outgoing check valve 22.

15 Fluid outlet 15 is disposed at the highest possible point in housing 11, as viewed in Figure 1, to preclude the entrapment of air in chamber 12 above outlet 15. With such a location of outlet 15 pump 10 will operate in either the horizontal position of Figure 1, or a vertical position without entrapping and pumping air from chamber 12. Housing 11 also has a circumferential groove 11B adjacent inlet 14 and 15 to preclude any possibility of diaphragm assembly 30 from sealing off said inlet or outlet. The propellant chamber 13 has a fluid port 16 through which pressurized propellant fluid, for example compressed carbon dioxide gas, may be admitted or released.

20 The diaphragm assembly 30 includes a reinforcing plate 31, a motor stem 32 and the diaphragm 33. The plate 31 is sub-

- 4 -

- 5 -

1 stantially planar or flat, is relatively rigid under the forces
it is subjected to, and is preferably made of metal. The plate
31 has a front side 34 facing towards the pumping chamber 12,
and a rear side 35 facing towards the propellant chamber 13. A
5 central aperture 36 is in the middle of the plate 31, and
perforations 37 in the form of round holes through the plate 31
are in a pattern 38 around and generally concentric to the aper-
ture 36.

10 The motor stem 32 is an elongate member, preferably of
metal, and is mounted to the plate 31. An elongate body 40 of
the stem 32 is passed through the plate aperture 36 and a dia-
metrically enlarged head 42 abuttingly engages against the
plate front side 34. The elongate stem axis 41 is substantially
perpendicular to the plane of the plate 31. The stem 32 projects
15 from the plate rear side 35, through the propellant chamber 13,
and through a bore 23 defined by a stem guide 11A in the rear
side of the housing 11. The stem 32 is reciprocable in the
stem guide bore 23 and a seal 43 fluid tightly seals the stem 42
to the housing bore 23.

20 It is advantageous to place seal 43 on stem 32 rather than
in the stem guide 11A because it is easier to repair and assemble.
Seal 43 may be replaced merely by removing stem 32 and the di-
aphragm assembly 30 from the pump with the construction of the
present invention. In addition, if seal 43 were placed within
25 the stem guide 11A a retaining clip would be needed to hold it
in place. Stem guide 11A and housing 11 are fabricated from a
thermoplastic polyester of low friction material to permit the
reciprocation of stem 32 and seal 43 therein. An example of a

- 5 -

- 6 -

1 suitable material is, Valox T.M., manufactured by the General
Electric Company.

5 A spring motor 17 biases the motor stem 32, plate 31,
and most of the diaphragm 33 towards the rear of the housing 11
and towards the propellant chamber 13. The spring motor 17 has
a spring 18 compressed between the housing 11 and a spring re-
tainer 19 held on and to the motor stem 32 by a keeper 20 in
the stem. Retainer 19 in conjunction with spring 18 has a
self-centering action on stem 32. That is, it tends to direct
10 stem 32 along the central axis of bore 23 in stem guide 11A.

15 An important feature of the pump 10 and the diaphragm as-
sembly 30 is the diaphragm per se 33 and its construction with
respect to the plate 31 and stem 32. The diaphragm 33 is contin-
uous, specifically it is of integral one-piece construction and
has a front layer 51 on the plate front side 34, a rear layer
52 on the plate rear side 35 and a resiliently flexible annular
bellows 53 around and to the outside of the plate 31 and the
front and rear layers 51, 52. To the outside of the bellows
section 53 is an annular V-clamp ring 54 which clamps a bead
53A of bellows section 53 in a fluid tight manner between the
20 two respective pieces of the housing. The front layer 51 is
imperforate and generally monolithic and completely covers the
plate 31 and stem 32 from the pumping chamber 12. The front
layer 51 has a convex section 55 projecting into the pumping
chamber 12 and imperforately covering the stem enlarged head 42.
The covered stem 32 may be welded to the plate 31 and this type
25 of construction is particularly useful if the diaphragm assembly
30 is to be driven by a mechanical or electrical device such as

- 6 -

- 7 -

1 a cam, lever or solenoid (not shown) operatively engaging the
motor stem 32 and pushing it inwardly. In the illustrated
pneumatically powerable mode, the stem 32 need not be welded
to plate 31. The diaphragm 33 and in particular the center and
5 convex section 55 thereof, mechanically retains the stem enlarged
head 42 abutted against the plate front side 34. The rear layer
52 is abutted against and secured to the stem 40 immediately ad-
jacent the plate aperture 36. Enlarged head 42 is both mechan-
ically abraded and adhesively secured to diaphragm convex section
10 55 thus forming a fluid tight seal. This precludes propellant
gas from bleeding through diaphragm 33 in the region of head
42 and convex section 55.

The diaphragm 33 is also both mechanically and adhesively
secured to the plate 31 and stem 32. The plate 31 is mechanically
15 abraded on both of the front and rear sides 34, 35 and covered
with a thin layer of adhesive (not shown). The elastomeric
diaphragm 33 is molded in-situ about the stem 32 and plate 31
and integral elastomeric pins 58 are molded through the plate
perforations 37. These pins 58 are integral with both the front
20 layer 51 and the rear layer 52 and mechanically retain the layers
51, 52 against the plate 31.

The rear layer 52 has a plurality of perforations 56 which
open the propellant chamber. These rear layer perforations 56
enable mechanical support of the plate 31 during molding of the
25 diaphragm 33. The plate perforations 37 and the diaphragm pins
58 therein are laterally spaced from any of the rear
layer perforations 45 so that every diaphragm pin 58 is adjoined
to both the front and rear layers 51, 52 and neither of the dia-

- 7 -

- 8 -

1 phragm layers can be pulled from the plate 31 without putting
all adjacent pins 58 under tensile stress.

5 The diaphragm layers 51, 52 and plate 31 are intended to
be substantially perpendicular to the motor stem 32, and are held
off but closely spaced from the housing 11 by concentric C-shaped
arcuate ribs 25 standing off the inside of the housing 11 in the
propellant chamber and between the housing 11 and the plate rear
side 35. The ribs 25 support the plate 31 and diaphragm layers
10 51, 52 in a position perpendicular to the stem 32 in the position
illustrated in Figure 1. The propellant fluid port 16 is radially
within the opening between ends of the C-shaped ribs 25. Thus,
fluid pressure is rapidly and evenly distributed within all of
the ribs 25 against the rear layer 52 of diaphragm 33 so that
15 the plate 31 and diaphragm layers 51, 52 remain perpendicular
to the motor stem 32 as they leave or return to the ribs 25.

As illustrated in Figure 1, the space behind diaphragm 33
at the beginning of a pumping stroke is kept to a minimum, namely
it is defined by the height of ribs 25. This small space provides
definite advantages. For example, it increases the response time
20 of the pump to incoming propellant pressure and it maximizes the
volume of fluid pumped per stroke for a housing of a given size.
Furthermore, as stated above, the ribs 25 evenly distribute the
propellant behind diaphragm 33 further increasing the response
time of the pump to the driving force of the propellant.

25 In the operation and use of the pump 10 and the diaphragm
assembly 30 therefor, the diaphragm assembly 30 has been fabricated
as an assembly of the plate 31, stem 32 and diaphragm 33 and it
is one component, and cannot be broken down or taken apart.

- 8 -

- 9 -

1 The diaphragm assembly 30 is placed in the housing 11, the spring
motor 17 is operatively connected, and the diaphragm V-clamp ring
54 secures the two pieces of housing 11 together in a fluid tight
manner.

5 The pump fluid inlet 14 is fluidly connected to a source
of fluid intended to be pumped, the pump fluid outlet 15 is con-
nected to a destination to which fluid from the source is to
be pumped, and the propellant fluid port 16 is connected to a
source of pressurized propellant fluid, preferably but not neces-
10 sarily a gas, under the control of suitable valving for intermit-
tent application and relief of propellant pressure.

When the pump 10 is on standby and awaiting use, the dia-
phragm assembly 30 is in the position and configuration shown
best in Figure 1. The spring motor 17 exerts a constant bias
15 on the diaphragm assembly 30 and keeps the diaphragm layers 51,
52 and plate 31 against the ribs 25 and perpendicular to the stem
32. As stated hereinbefore, this minimizes the volume of the
propellant chamber 13 and maximizes the volume of the pumping
chamber 12. The stem enlarged head 42 is positively abutted against
20 the plate 31 and cannot come apart. There is no metal exposed
to fluid in the pumping chamber 12.

Propellant pressure is selectively applied through the
port 16 and is evenly and rapidly distributed in the propellant
chamber 13 by ribs 25 behind diaphragm 33. As the propellant
25 chamber 13 expands under propellant pressure, the pumping chamber
12 is reduced in volume and the inlet check valve 21 closes and
the outlet check valve 22 opens and fluid is pumped out of the
outlet 15. The propellant pressure is applied equally on the

- 9 -

- 10 -

1 diaphragm rear layer 52 and bellows 53. Under this pressure
the rear diaphragm layer 52 retains the diaphragm bellows 53 and
the plate 31. The propellant force is taken by the plate 31,
transferred through the head 42 to the stem 32 which is then drawn
5 into the housing 11 as the spring motor 17 is compressed during
pumping.

When the propellant pressure is relieved, the spring motor
17 begins to pull the diaphragm assembly 30 back. The outlet
check valve 22 closes and the inlet check valve 21 opens and new
10 fluid is drawn from the source and into the pump chamber 12. This
new fluid is drawn by suction and the diaphragm 33 and plate
31 will be negatively pressurized. The spring motor 17 pushes
the motor stem 32 outward, the stem head 42 pulls the plate 31,
and the plate pulls the diaphragm front layer 51 and pushes
15 the diaphragm rear layer 52. The front and rear layers 51, 52
both pull the bellows 53. The front layer 51 cannot separate
from the plate 31 under vacuum because of the bonding and the
pins 58 which tie the front and rear layers 51, 52 together and
to the plate 31.

20 The pump 10 and diaphragm assembly 30 offer substantial
advantages in the handling of food fluids or corrosives. There
is no metal to fluid contact, no possibility of failure between
the plate 31 and the stem 32, and the diaphragm 33 is virtually
inseparable from the plate 31 and stem 32. There are no crevices
25 for contamination and cleanability is enhanced. The problem of
the diaphragm bellows being blown over the front side of the
rigid plate has been solved without the necessity for a rigid
block or other device on the front side of the diaphragm. The
pump 10 is able to be pressurized at 50 PSIG without the erratic

- 10 -

- 11 -

1 collapse of diaphragm and short delivery of pumped fluid. A
very high strength spring motor may be used with this improved
diaphragm and pump and the suction capabilities are sufficient
for lifting beverage syrup concentrates at least twenty feet,
5 (6.1 meters).

These advantages, usages and many other usages will be
found and realized by those versed in the art, and although various
minor modifications may be suggested and employed by those who
are versed in the art, be it known that I wish to embody within
10 the scope of the patent granted hereon all such embodiments as
reasonably come within the scope of my contribution to the art.

- 11 -

- 12 -

WE CLAIM AS OUR INVENTION

1 1. A diaphragm assembly for a diaphragm type fluid pump,
2 comprising:
3 a substantially planar and rigid diaphragm having a front
4 and rear side and a central aperture therethrough;

5 an elongate and rigid motor stem mounted in and through
6 the plate aperture;

7 an enlarged head on the stem, said head being abutted
8 against a front side of the plate; and

9 a relatively flexible elastomeric diaphragm molded to
10 the plate and stem, and having an imperforate layer covering
11 the entirety of the plate front side and the stem head.

1 2. A diaphragm assembly according to claim 1, in which
2 the plate and stem are metal and are welded to one another, the
3 stem head being on a front side of the plate and with the stem
4 elongately projecting substantially from a rear side of the
5 plate.

1 3. A diaphragm assembly according to claim 2, in which the
2 diaphragm has a rear layer mechanically secured to the plate rear
3 side.

1 4. A diaphragm assembly for a diaphragm type fluid pump,
2 comprising:
3 a substantially planar rigid diaphragm plate having a

4 front and rear side;

- 12 -

- 13 -

5 an elongate rigid motor stem mounted in and to the dia-
6 phragm plate;

7 a relatively flexible elastomeric diaphragm permanently
8 secured to the plate and stem by being molded in mechanical
9 engagement therewith; and in which

10 the stem is permanently fixed in the plate by the
11 elastomeric diaphragm.

1 5. A diaphragm assembly according to claims 1 or 4,
2 in which the plate has a pattern of perforations around the stem,
3 and in which the diaphragm has

4 a monolithic front layer so secured to the plate,
5 integral pins extending from the front layer and through
6 the plate perforations, and

7 a rear layer integrally connected to the front layer by
8 and through the pins.

1 6. A diaphragm assembly according to claim 5, in which
2 the diaphragm rear layer is perforated, and in which the plate
3 perforations and the diaphragm pins therein are spaced from any
4 of the perforations in the diaphragm rear layer.

1 7. A diaphragm assembly according to claim 1, in which
2 the plate front and rear surfaces are both mechanically abraded.

1 8. A diaphragm assembly according to claim 7, including
2 structural adhesive on both of the front and rear surfaces of
3 the plate.

- 13 -

- 14 -

1 9. A diaphragm assembly according to claim 5, in which the
2 diaphragm rear layer abuts against the stem.

1 10. A diaphragm assembly according to claim 5, in which
2 the diaphragm pins have a cross-section thickness substantially
3 greater than the thickness of either diaphragm layer.

1 11. A diaphragm assembly according to either of claims
2 or 4 wherein said enlarged head on said stem is both mechanical-
3 ly abraded and adhesively secured to said elastomeric diaphragm.

1 12. In a pneumatically powerable single action fluid pump
2 having a housing, a diaphragm dividing the interior of the housing
3 into fluidly discrete pumping and propellant chambers, a fluid
4 inlet to and a fluid outlet from the pumping chamber, and a fluid
5 port into the propellant chamber for admittance and exhaust of
6 pneumatic propellant gas, the improvement comprising:
7 a planar, substantially rigid diaphragm fastened to
8 the diaphragm, said plate having a front side facing the pumping
9 chamber and a rear side facing the propellant chamber;

10 an elongate rigid motor stem connected centrally to the
11 plate and projecting from the rear side of the plate through the
12 propellant chamber and a rear side of the housing to a spring
13 motor biasing the stem, plate and diaphragm away from the pumping
14 chamber; and

15 a contiguous relatively flexible elastomeric diaphragm
16 molded to the plate and having an imperforate layer on the plate
17 front side, said front side layer physically precluding any ex-

- 14 -

- 15 -

18 posure of the plate or stem to fluid within the pumping chamber.

1 13. The fluid pump improvement of claim 12, including
2 an enlarged head on the motor stem, said head being on and being
3 abutted against the front side of the diaphragm plate.

1 14. The fluid pump improvement of claim 13, in which the
2 diaphragm imperforate layer includes a convex section protruding
3 to the pumping chamber side, said layer and convex section imper-
4 forately covering the motor stem enlarged head.

1 15. The fluid pump improvement of claim 12, including
2 spacer means standing off the inside of the housing in the propel-
3 lant chamber between the housing and the rear side of the diaphragm
4 plate, for supporting the diaphragm plate and the diaphragm layer
5 substantially perpendicular to the motor stem.

1 16. The fluid pump improvement of claims 12, 13, or 15,
2 in which the plate and stem are not permanently adjoined to one
3 another, and in which the diaphragm includes means around the head
4 of the motor stem for retaining the stem in the plate.

1 17. In a pneumatically powerable single action fluid pump
2 having a housing, a diaphragm assembly dividing the interior of the
3 housing into fluidly discrete pumping and propellant chambers,
4 a fluid inlet to and a fluid outlet from the pumping chamber,
5 and a fluid port into the propellant chamber for admittance and
6 exhaust of pneumatic propellant gas, the improvement comprising;

- 15 -

- 16 -

7 an elongate rigid motor stem connected to the diaphragm
8 and projecting from a rear side thereof through the propellant
9 chamber and a rear side of the housing to a spring motor
10 biasing the stem and diaphragm assembly away from the pumping
11 chamber; and

12 spacer means standing off the inside of the housing in
13 the propellant chamber between the rear side of the housing and
14 said diaphragm assembly, said spacer means defining the size of said
15 propellant chamber at the beginning of a pump stroke.

1 18. The fluid pump improvement of either of claims 15
2 or 17 wherein said spacer means includes a plurality of spaced
3 elements arranged in a configuration which causes a substantially
4 even distribution of said propellant gas against the rear side
5 of said diaphragm assembly.

1 19. The fluid pump improvement of either of claims 12 or
2 17 wherein said housing includes stem guide means extending from
3 the rear side of said pump housing, said stem guide means including
4 a bore for slidably receiving said elongate rigid motor stem
5 and sealing means disposed on said motor stem for sealing engage-
6 ment with said bore.

1 20. The pump improvement of either of claims 12 or 17
2 wherein said fluid outlet from the pumping chamber is disposed at
3 substantially the highest point in a front wall of said housing.

1 21. The pump improvement of claims 12 or 17 wherein said

- 16 -

- 17 -

2 fluid inlet and fluid outlet of said pumping chamber are disposed
3 in a front wall of said housing and said front wall has an annular
4 recess extending around and adjacent to said fluid inlet and outlet.

1 22. In a pneumatically powerable single action fluid pump
2 having a housing, a diaphragm assembly dividing the interior of
3 the housing into fluidly discrete pumping and propellant chambers,
4 a fluid inlet to and a fluid outlet from the pumping chamber,
5 a fluid port into the propellant chamber for admittance and
6 exhaust of pneumatic propellant gas, the improvement comprising;
7 a front housing portion and a rear housing portion;
8 an elongate rigid stem connected centrally to the dia-
9 phragm and projecting from the rear side of the plate through the
10 propellant chamber and the rear housing portion to a spring
11 motor biasing the stem, plate and diaphragm away from the pumping
12 chamber;
13 stem guide means in said rear housing defining a bore
14 in which said rigid motor stem is slidably received;
15 sealing means on said rigid motor stem for sealingly
16 engaging said bore; and
17 clamp means for holding a peripheral portion of said
18 diaphragm assembly between said front and rear housing portions.

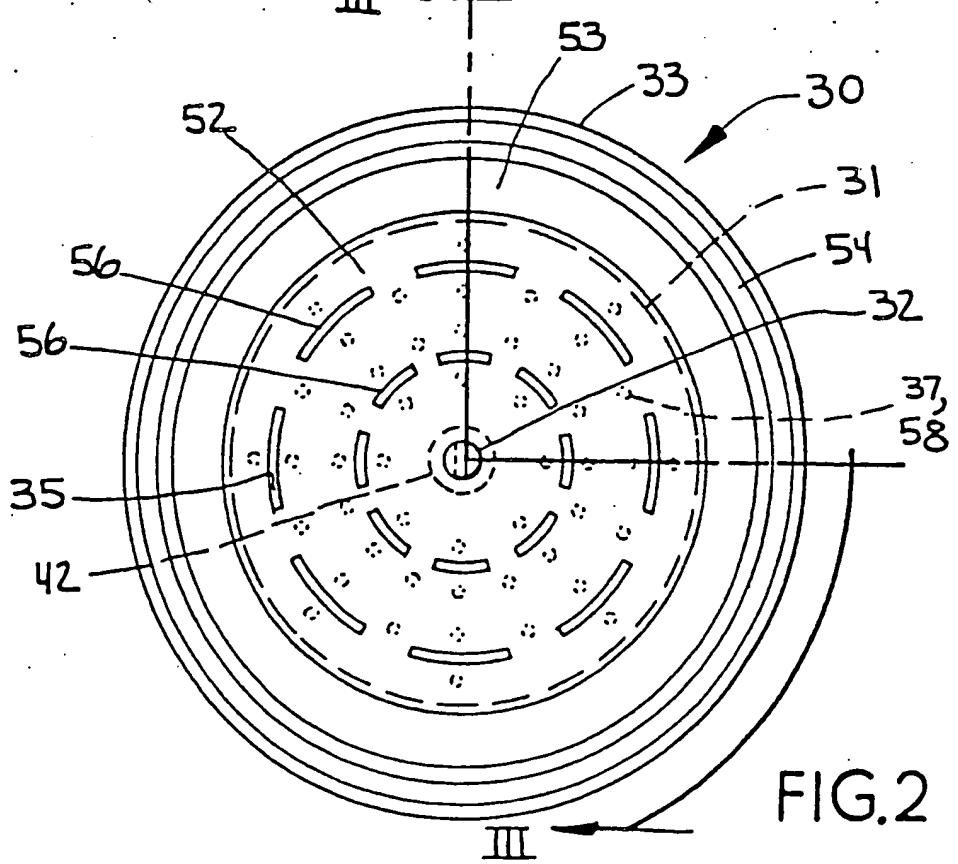
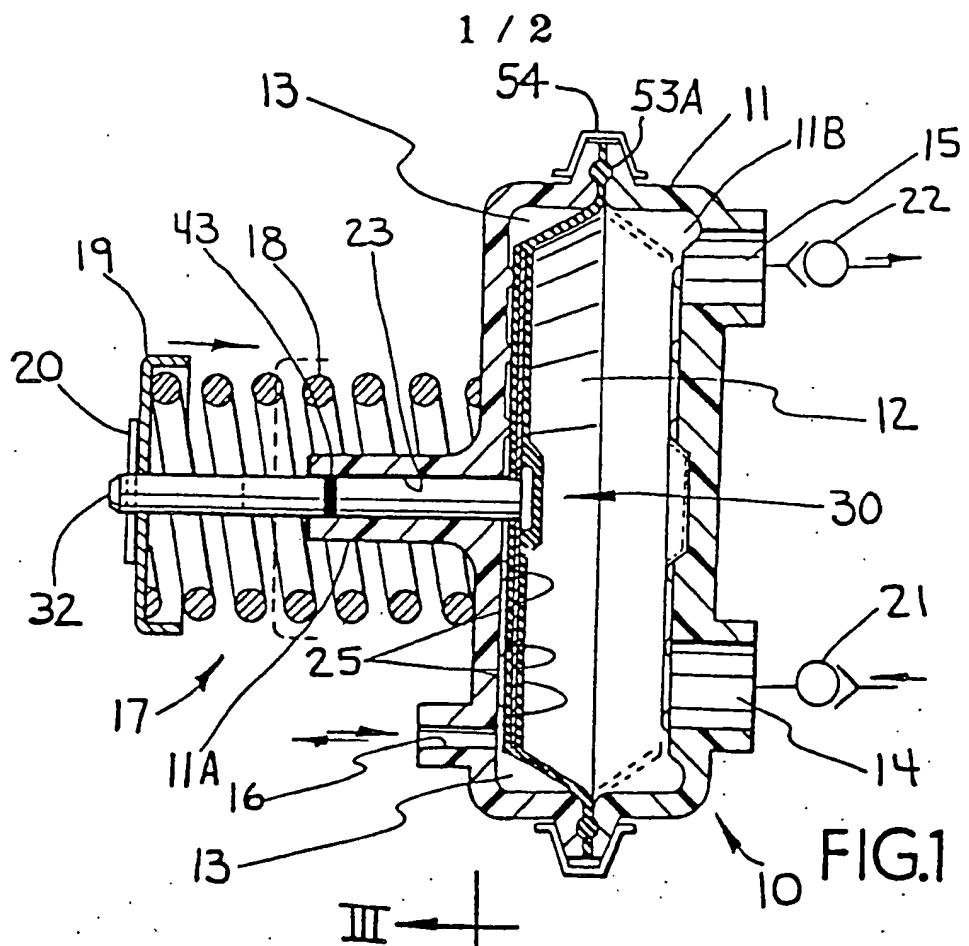
1 23. The fluid pump improvement of claim 22 wherein said
2 peripheral portion of said diaphragm assembly has an annular
3 bead which is clamped between said front and rear housing
4 portions.

- 17 -

- 18 -

1 24. The fluid pump improvement of either of claims 12,
2 17 or 22, wherein said spring motor includes a coil spring disposed
3 concentrically around said elongate rigid stem outboard of said
4 motor housing and spring retainer means on an outboard end of
5 said stem, said spring retainer means having a cup shaped opening
6 for receiving one end of said coil spring therein.

- 18 -



2 / 2

